NRC & PSEG Meeting

Hope Creek Special Inspection and Technical Issues

January 12, 2005

Nuclear Regulatory Commission-Region I
King of Prussia, PA

NRC Representatives

- S. Collins, Regional Administrator, Region I
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- D. Collins, Senior Project Manager, NRR
- T. Walker, Senior Communications Coordinator, Region I

Agenda

- Introductions and NRC Opening Remarks
- Special Inspection Team Results
  - NRC Presentation
  - PSEG Response
- NRC Review of Technical Issues
  - NRC Presentation of the Technical Issues
    - High Pressure Coolant Injection Turbine Exhaust Line
    - 'B' Reactor Recirculation Pump Issues
  - PSEG Response
- Additional NRC Actions Planned
- Break
- Public Questions and Comments to NRC Staff

NRC Special Inspection Team Exit Meeting (Hope Creek)

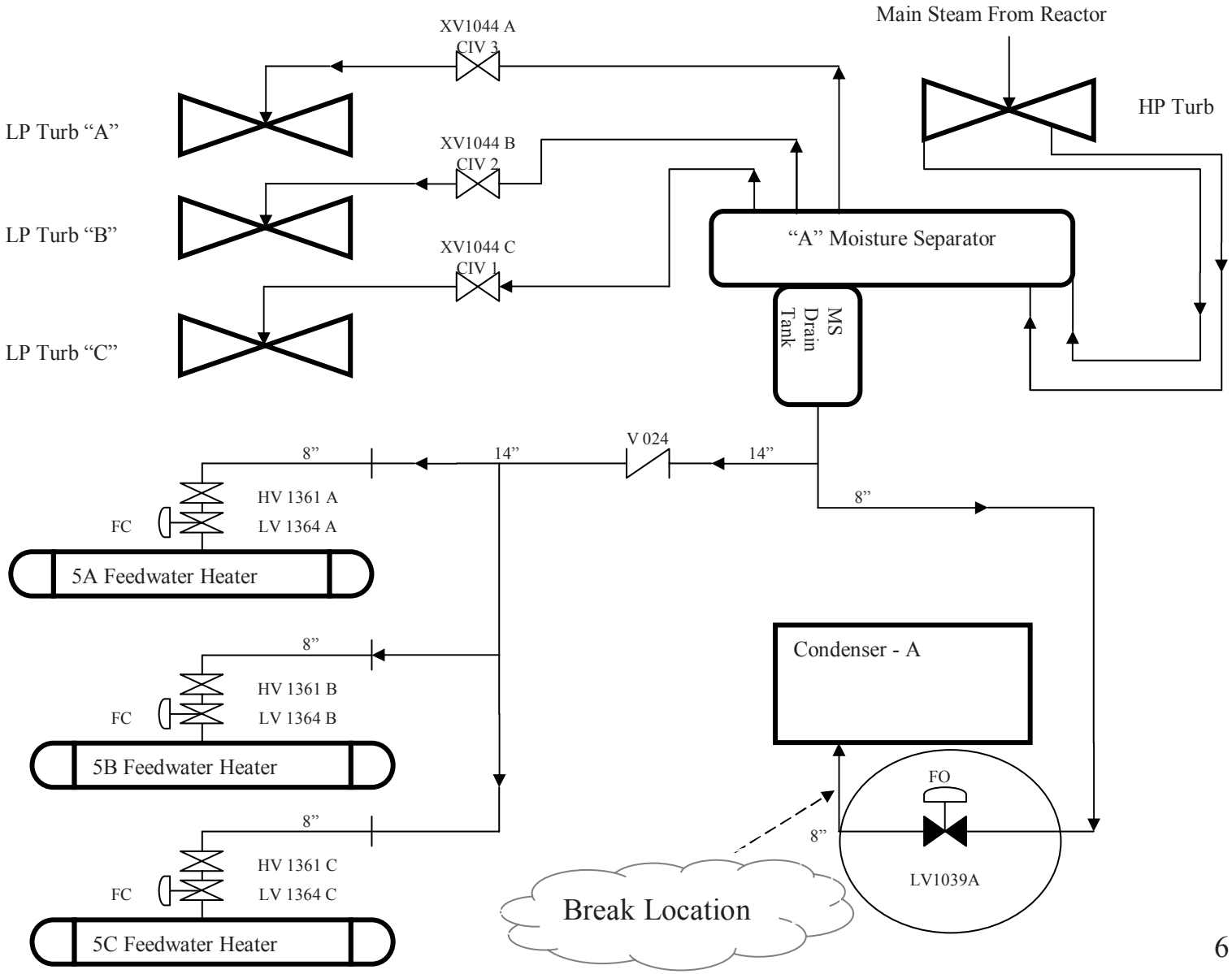
Inspection Report 50-354/2004-013

January 12, 2005

Introduction / Background

- Event Chronology
  - Moisture separator drain tank pipe failure
  - Plant shutdown and cooldown
    - Some equipment and operational challenges during cooldown phase
- Special Inspection Team (SIT)
  - Criteria
  - Team Staffing
  - Charter / Objectives

System Diagram



Event Overview

- Initial response prompt / appropriate
- Licensee successful in achieving cold shutdown
- Some operational / equipment issues represented challenges while progressing to cold shutdown conditions
- No impact on public health and safety

Event Analysis

- PSEG Actions
  - Extensive inspections conducted
  - Failure analysis performed by vendor
  - Three root cause evaluations
  - Multiple corrective actions planned and implemented (cause / equipment related)

Event Analysis

- Engineering staff did not properly evaluate and recommend appropriate actions for failed moisture separator drain tank level control valve
- Preliminary significance is low to moderate
  - Initiating event resulted in isolation of main condenser (normal heat removal)

Operational / Equipment Issues

- High pressure coolant injection (HPCI) system valve malfunction
- Reactor core isolation cooling (RCIC) flow oscillations
- HPCI vacuum pump

Radiological Assessment

- No impact to health or safety of public
- Radiological release – less than 2 % of Regulatory Limits

Conclusions

- Event
  - Unit was safely shutdown by operators and placed in a stable condition
  - Radiological release well below regulatory limits
  - No impact on public health and safety
- Findings
  - Improper evaluation of degraded condition caused the event
  - Operators challenged by equipment issues, but all equipment could have performed its intended function

PSEG Response to Special Inspection Team's Findings

NRC Review of Technical Issues

- HPCI turbine exhaust line
- ‘B’ reactor recirculation pump issues

NRC Staff's Assessment of the HPCI Turbine Exhaust Line Issue

Raymond K. Lorson, Chief,
Materials and Structural Engineering Branch,
Division of Reactor Safety (DRS)

HPCI Turbine Exhaust Line

- Initial shutdown observations and testing identified a potential water hammer concern
- Further review found no evidence of a water hammer event
- System walkdowns and non-destructive testing did not identify any damage
- Modifications and repairs implemented to minimize the potential for a water hammer event

NRC Staff's Assessment of the Hope Creek Reactor Recirculation Pump Issue

Eugene V. Imbro, Chief,
Mechanical and Civil Engineering Branch,
Office of Nuclear Reactor Regulation (NRR)

What are the Safety Questions Related to the 'B' Reactor Recirculation (RR) Pump

- Hope Creek 'B' RR pump has exhibited high vibration levels
- High vibration levels may induce loads on the pump shaft and lead to shaft failure
- RR pumps perform a safety-related function to maintain the reactor coolant pressure boundary
- Shaft failure could damage pump seals and result in leakage through seals
- Plant operation with a likelihood of leakage through the RR pump seals is unacceptable
- The occurrence of a seal LOCA is a safety concern to the NRC

Why Is It Safe to Operate the 'B' RR Pump with Existing Shaft?

- The licensee is implementing an enhanced vibration monitoring program for the RR pumps
  - Continuous monitoring of pump vibration levels
  - Definitive alarm set-points
  - Timely operator actions to protect the pump from shaft failure
- The NRC staff reviewed the details of the licensee's vibration monitoring plan and operating procedures
- The NRC staff has confidence that:
  - Critical vibration levels in RR pump shaft can be detected early
  - Timely operator actions will be taken

Technical Bases for NRC Staff's Findings on the Hope Creek RR Pump

- The NRC staff focused on three key questions:
  1) What operating plant experience exists that demonstrates RR pump shaft failure at Hope Creek is unlikely for another cycle?
  2) What data exists demonstrating that cracks in the RR pump shaft can be detected in a timely manner to enable operators to take appropriate actions?
  3) What are the consequences of a RR pump shaft failure during normal plant operations?
- The NRC staff also reviewed the licensee's vibration monitoring plan
- The details of the staff's technical bases are discussed in the next slides

Understanding the Crack Failure Mechanism in the RR Pump Shaft

- GE Services Information Letter (SIL) 459 indicates Byron-Jackson RR pump shafts are prone to thermally induced cracking
- Thermally induced cracks initiate in the axial direction and are relatively benign
- Additional mechanical loads on the shaft can cause cracks to grow circumferentially and could lead to complete shaft failure
- Length of time for axial cracks to transition to circumferential cracks depends on the magnitude of the mechanical loads
- Circumferential cracks can grow rapidly (hours or days) prior to shaft failure
- The magnitude of the mechanical loading on Hope Creek's shaft is unknown
- The remaining shaft life of Hope Creek's RR pumps cannot be reasonably predicted or calculated

1) Operational Experience on RR Pump Vibration and Shaft Failures

- No domestic boiling-water reactor (BWR) has experienced complete shaft failure in the RR pump
- One BWR experienced severe RR shaft cracking that was detected prior to failure
- Hope Creek has higher-than-average vibration levels in its ‘B’ RR pump
- Hope Creek’s RR pump vibration alarm limits are consistent with vendor recommendations
- The vibration levels of the Hope Creek RR pumps are within the range of operational experience of BWRs with similar RR pumps

2) Experience with Vibration Monitoring to Detect Shaft Cracking

- A BWR and several pressurized-water reactors (PWRs) detected cracked RR pump shafts using a vibration monitoring program prior to failure
- Experience shows that continuous monitoring of pump vibration levels can reasonably detect shaft cracking prior to complete failure
- Hope Creek's RR pump shaft material can tolerate relatively large cracks allowing more time for detection prior to complete failure

3) Consequences of a RR Pump Failure

- If the pump shaft completely fails, some damage to the seal is likely to occur
- If a seal failure results, leakage of reactor coolant through shaft clearances will occur
- Leakage is limited by tight shaft clearances and is bounded by a design-basis, small-break LOCA
- The Hope Creek plant is designed to allow isolation of the RR pump with isolation valves in the RR system
- The consequences of a RR pump shaft failure is within Hope Creek's licensing basis

NRC Staff's Evaluation of the Hope Creek RR Pump Vibration Monitoring Plan

- Licensee's vibration monitoring plan consists of:
  - Continuous monitoring of the overall pump radial vibration with alarms set at:
    - 11 mils for operators to reduce pump speed
    - 16 mils for operators to remove the pump from service
  - Continuous monitoring of 1X and 2X vibration amplitude and phase angle with alarms in the control room to initiate timely operator actions
- The normal vibration levels for the RR 'B' pump at Hope Creek are in the range of 8-10 mils
- Continuous monitoring of pump vibration provides confidence that changes in the vibration levels can be detected early
- The licensee's operating procedures provide timely actions to prevent complete shaft failure

Conclusions

- The NRC staff concludes that the licensee's vibration monitoring plan for the Hope Creek RR pumps provide confidence that the RR pumps can be operated safely for the next cycle

PSEG Response to the NRC's Review of Technical Issues

Additional NRC Actions Planned

- Issue a Confirmatory Action Letter (CAL) on PSEG's commitments regarding the 'B' reactor recirculation pump
  - Implementation of a continuous vibration monitoring program
  - Inspection of pump components and replacement of the pump shaft no later than the next refueling outage
  - Notification of the NRC prior to modifying the vibration monitoring program to allow ample time for NRC review
- Inspections throughout the operating cycle will verify that PSEG adheres to commitments
- NRC evaluating generic aspects of recirculation pump issues

Additional NRC Actions Planned (Continued)

- Substantial inspector oversight during the startup of Hope Creek from the ongoing refueling outage
- Continue actions per Reactor Oversight Process (ROP) deviation established in August 2004
  - More inspection
  - More oversight
  - Increased oversight will continue until PSEG has achieved substantial, sustainable progress
- Future meetings between NRC and PSEG which will be open to public observation
  - Annual assessment meeting
  - Semi-annual management meetings on work environment at the station

Reference Sources

- Salem and Hope Creek Website

  http://www.nrc.gov/reactors/plant-specific-items/hope-creek-salem-issues.html

- Public Electronic Reading Room

  http://www.nrc.gov/reading-rm/adams.html

- Public Document Room

  1-800-397-4209

- Public Affairs Office

  (610) 337-5330/5331

Break

Public Questions and Comments to NRC Staff